Consultative Committee for Space Data Systems

DRAFT RECOMMENDATION FOR SPACE DATA SYSTEM STANDARDS

PROXIMITY-1 SPACE LINK PROTOCOL—

PHYSICAL LAYER

CCSDS 211.1-~~B~~P-1.1

~~BLUE BOOK~~PINK SHEETS

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(WHEN THIS RECOMMENDATION IS FINALIZED, IT WILL CONTAIN THE FOLLOWING STATEMENT OF AUTHORITY:)

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DOCUMENT CONTROL

Document	Title and Issue	Date	Status
CCSDS 211.0-B-1	Proximity-1 Space Link Protocol	October 2002	Superseded
CCSDS 211.1-B-1	Proximity-1 Space Link Protocol—Physical Layer	April 2003	Current issue (see note)
CCSDS 211.1-P-1.1	Proximity-1 Space Link Protocol—Physical Layer	November 2003	Current draft update: Assigns channel number 0 as specified to match current use by Mars Odyssey and Mars Express. Due to channel number 0 assignment, renumber channel assignments starting with 0 (instead of 1) through 15 (instead of 16). Provides implementers with a requirement on how much their implementation can deviate from commanded Proximity-1 data rate.

Note

This document contains the Physical layer specification originally published as part of CCSDS 211.0-B-1, *Proximity-1 Space Link Protocol*.

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configured, hailing can occur on an agreed-to channel. NASA Mars Odyssey and ESA Mars Express, which are fixed-frequency transceivers, utilize Channel 0.

3 See the MAC sublayer for further details of hailing in the link establishment process. There are various parameters associated with the Hail activity that are defined in the MIB. See reference [4], annex B for these enterprise-specific parameters.

4 Hailing is accomplished for half and full duplex links using an asynchronous channel and an asynchronous data link.

5 It is recommended that after link establishment through hailing is accomplished, one transitions over to the working channel (if available) as soon as possible.

3.4.1.4 Single Forward and Single Return Frequency Pairs

NOTE – Forward and return link frequencies may be coherently related or non-coherent.

3.4.1.4.1 The following seven additional channels (fixed single forward and return frequency pairs) are defined for Proximity-1 operations:

a) Channel ~~2~~0. In the case where the system requires only one return frequency, associated with the forward 437.1 MHz frequency, the return frequency shall be 401.585625 MHz (147/160 turnaround ratio).

b) Channel ~~3~~2. In the case where the system requires only one return frequency, associated with the forward 439.2 MHz frequency, the return frequency shall be 397.5 MHz (1325/24*61 turnaround ratio).

c) Channel ~~4~~3. In the case where the system requires only one return frequency, associated with the forward 444.6 MHz frequency, the return frequency shall be 393.9 MHz (1313/38*39 turnaround ratio).

3.4.1.4.2 In the case of the following four fixed return frequency applications, the forward frequency shall be defined within the 435 to 450 MHz band. See table 3-2.

a) Channel ~~5~~4: Return Frequency 401.4 MHz;

b) Channel ~~6~~5: Return Frequency 402.0 MHz;

c) Channel ~~7~~6: Return Frequency 402.6 MHz;

d) Channel ~~8~~7: Return Frequency 403.2 MHz.

NOTE – Channels ~~9~~8 through ~~16~~15 are defined in the SET PL EXTENSIONS directive; see reference [4], annex A. The assignment of specific frequencies to these channels is reserved by CCSDS.

Table 3-2: Proximity-1 Channel Assignments ~~1~~0 through ~~8~~7 (Frequencies in MHz)

Channel (Ch) Number	Forward (F) Frequency	Return (R)Frequency
~~1~~0	437.1~~435.6~~	401.585625~~404.4~~
~~2~~1	435.6~~437.1~~	404.4~~401.585625~~
~~3~~2	439.2	397.5
~~4~~3	444.6	393.9
~~5~~4	Within 435 to 450	401.4
~~6~~5	Within 435 to 450	402.0
~~7~~6	Within 435 to 450	402.6
~~8~~7	Within 435 to 450	403.2

3.4.1.5 Multiple Forward and Multiple Return Frequencies

NOTE – Forward and return link frequencies may be coherently related or non-coherent.

In the case where there is a need for one or multiple return frequencies paired with one or multiple forward frequencies, the forward frequencies shall be selected from the 435 to 450 MHz band in 20 kHz steps and the return frequencies shall be selected from 390 to 405 MHz in 20 kHz steps. These frequency pairs shall be distinct from the frequency pairs defined in Channels ~~1~~0 through ~~8~~7. The forward and return frequency components of Channels ~~9~~8 through ~~16~~15 are reserved for this purpose.

3.4.2 S-BAND FREQUENCIES

S-Band frequencies are intentionally left unspecified until a user need for them is identified.

NOTE – If such a need arises, users are requested to contact the CCSDS Secretariat at: ccsds@lists.hq.nasa.gov.

3.4.3 X-BAND FREQUENCIES

X-Band frequencies are intentionally left unspecified until a user need for them is identified.

NOTE – If such a need arises, users are requested to contact the CCSDS Secretariat at: ccsds@lists.hq.nasa.gov.

3.4.4 KA-BAND FREQUENCIES

Ka-Band frequencies are intentionally left unspecified until a user need for them is identified.

NOTE – If such a need arises, users are requested to contact the CCSDS Secretariat at: ccsds@lists.hq.nasa.gov.

3.4.5 POLARIZATION

Both forward and return links shall operate with RHCP.

3.4.6 MODULATION

3.4.6.1 The PCM data shall be Bi-Phase-L encoded and modulated directly onto the carrier.

3.4.6.2 Residual carrier shall be provided with modulation index of 60° ± 5%.

3.4.6.3 The symmetry of PCM Bi-Phase-L waveforms shall be such that the mark-to-space ratio is between 0.98 and 1.02.

3.4.6.4 A positive-going signal shall result in an advance of the phase of the radio frequency carrier. For directly modulated Bi-phase-L waveform,

a) a symbol '1' shall result in an advance of the phase of the radio frequency carrier at the beginning of the symbol interval;

b) a symbol '0' shall result in a delay.

3.4.7 DATA RATES

3.4.7.1 General

The Proximity-1 link shall support one or more of the following 12 discrete forward and return data rates, shown in bits per second: 1000, 2000, 4000, 8000, 16000, 32000, 64000, 128000, 256000, 512000, 1024000, 2048000.

3.4.7.2 Data Rate Stability

Generated data symbol period (equal to 1/data rate) shall not deviate by more than 0.01% on a symbol-to-symbol basis as measured at the output of the transceiver.

3.4.7.3 Data Rate Accuracy

Generated data symbol rates shall not deviate by more than 0.1% from the defined Proximity-1 rates as measured at the output of the transceiver. ~~and as measured on a symbol-to-symbol basis.~~

~~NOTE — This limits both the average deviation over time and symbol-to-symbol jitter to less than 0.1% of the specified Proximity-1 data rate.~~

3.5 PERFORMANCE REQUIREMENTS

3.5.1 DELIVERED BIT~~/SYMBOL~~ STREAM ERROR RATE

Link margins shall be designed to provide a Bit Error Rate (BER) less than or equal to 1×10^{-6} for asynchronous links.~~, i.e., links that do not use the R-S code. For fixed-length frame applications, link margins shall be designed to provide a Symbol Error Rate (SER) less than or equal to~~ ~~1×10^{-3}~~ ~~for links where R-S coding is performed in the Data Link layer.~~

3.5.2 CARRIER FREQUENCY STABILITY REQUIREMENTS

3.5.2.1 The long term oscillator stability (over the life of the mission) including all effects and over all operating conditions shall be 10 ppm.

3.5.2.2 The short term oscillator stability over 1 minute shall be 1 ppm.

3.5.3 RESIDUAL AMPLITUDE MODULATION

Residual amplitude modulation of the phase modulated RF signal shall be less than 2% RMS.

3.5.4 CARRIER PHASE NOISE

The minimum specification for the oscillator phase noise at 437.1 MHz shall be limited by the template shown in figure 3-1. The figure shows normalized power in dBc (where dBc refers to the power relative to the carrier power) vs. frequency offset from the carrier in Hz.